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Assessment of agricultural land fund in the Czech Republic, importance and future

V. Voltr

Institute of Agricultural Economics and Information

Abstract

Assessment of land depends on the production function of soil and additional connections given by environmental requirements, by the evaluation of public goods or by the requirements for formation a fair tax policy and even by the interests of landowners. Analysis of coherences during the soil appraisal shows a relatively strong dependence on the development of year-by-year yields and cost including subsidy policy, which is strongly reflected in the grasslands. Development of subsidies does not basically influence a long-term return and costs ratio for the production on arable land. The requirements for formation of prices are given due to the need for stability of the mutual relations between the quality of soil and climatic conditions, which manifests itself mainly in land consolidation or the categorization, useful for example for the determination of LFA. The comprehensive solution provides a system of land evaluation by cost-revenue relationships, which includes evaluation of environmental context on the base of the assessment of physical characteristics of soil and economic contexts in BPEJ categorization. The development of value system relations according to the proposed annual gross rental effects (HRRE) shows a relatively stable assessment of land fund for arable land. The adjusted system of land value permits preferably to express a pointed value of land, which corresponds to the trend of a points system of VÚMOP. The actual current rating BPEJ is proposed to make in dependence on the level of market prices to a one point. Due to the different trends in the market prices of arable land and grassland is proposed to introduce a separate assessment of arable land and grassland.

Key words

Soil evaluation; land value; production functions.

Anotace

Oceňování půdy závisí na produkční funkci půdy i dalších souvislostí daných environmentálními požadavky, oceněním veřejných statků nebo požadavky na tvorbu spravedlivé daňové politiky i zájmu vlastníků půdy. Analýza souvislostí při ocenění půdy ukazuje na poměrně velkou závislost ceny na vývoji ročních výnosů a nákladů a na dotační politice, která se silněji projevuje u travních porostů. Vývoj podpor však zásadním způsobem neovlivňuje dlouhodobý poměr výnosů a nákladů na výrobu na orné půdě. Požadavky na tvorbu cen jsou dány především potřebou stability vzájemných relací mezi kvalitou půdně-klimatických podmínek, která se projevuje zejména při pozemkových úpravách nebo při kategorizaci území, využitelné například pro LFA. Komplexní řešení nabízí systém hodnocení půdy podle nákladově-výnosových vztahů, který v sobě zahrnuje ocenění environmentálních souvislostí na základě vyhodnocení fyzikálních vlastností půdy a ekonomických souvislostí v kategorizaci BPEJ. Vývoj hodnotových vztahů podle navržených hrubých ročních rentních efektů (HRRE) ukazuje poměrně stabilní hodnocení půdního fondu pro ornou půdu. Nastavený systém hodnoty půdy je nejlépe vyjádřit bodovou hodnotou půdy, které trendově odpovídá relacím podle bodového systému VÚMOP. Vlastní aktuální hodnocení BPEJ je navrhováno provést v závislosti na úrovni tržních cen k jednomu bodu. Vzhledem k rozdílnému vývoji tržních cen orné půdy a travních porostů je navrženo zavést samostatné ocenění orné půdy a travních porostů.

Klíčová slova

Ocenění půdy, hodnota půdy, produkční funkce.

Introduction

Agricultural land fund is characterized by multifunctionality of its importance for the agriculture and society. The basic function of the agricultural land is its productive character for agricultural production, which is its primary value level from the point of economic relations given by the supply and demand for agricultural products. In terms of society-wide interests, the additional functions of agricultural land are more and more enforced, mainly resulting from the role of agricultural land for landscape maintenance. This role becomes particularly relevant in the context of the declining primary profitability of agricultural commodities given by the productivity of crops based on production costs and sales prices, as well as by increasing levels of social supports. In this context, grassland is an important component which is very sensitively perceived mainly because of the organic character of production and with regard to the economic system of animal production. Another important point can be seen in the demands for soil protection against various degradation factors. Overall, then decrease of suitable land for intensive agricultural production and increase of the areas which are enforced by various protective measures, with increased costs for growing crops.

As a consequence the situation leads to social requirements for security coverage of corresponding costs. The newly formed constraints are evaluated as the production of public goods, including financial support. If we want to evaluate land according to economic indicators, then the question arises of a philosophy of land value and the impact of the assessment in particular on long-term nature of its evaluating influences. This creates prerequisites for long-term shift in values. The resulting disproportion between the perception the quality of agricultural land as a production factor and the perception of land value as the value of public goods is reflected potentially even in its own pricing of land. It is necessary to answer the question whether and how support can be used to determine a land price according BPEJ and what is their role in the definition of other functions in society. Next questions as follows: (1) According to what land value has to be set, in case it has to be set; (2) What land value could be used for example for the implementation of comprehensive land consolidation or compensation for the removal from agricultural land? (3) What land value can be used for the evaluation of land ownership? (4) Is it necessary to distinguish between the land value including the calculation of public goods and without it, so particularly with the value of permanent cover of permanent grassland and with arable land, or take into account an universal assessment?

State of land evaluation by BPEJ

Qualified soil-ecological units (BPEJ) were established in 80th years of the last century primarily as a management tool in agricultural policy and reflected the quality of soil, based on the description of the major soil units, the inclusion of climatic regions and according to the configuration of land parcel due to slope, exposure, depth of soil and skeleton (Klečka [4], Mašát [7]) in the system of costs and revenues on agricultural production. The primary assessment of soil was based on a broad database of approximately 5000 plots monitored for 10 years. The assessment was regularly updated (Němec [8], Štolbová [13]), but primarily on the basis of expert assessments and global price parameters. A specific problem is the evaluation of agricultural crops, which is narrowed down to two types of land - arable land and grassland respectively. The introduced use was took into consideration in the price list of arable land itself and of permanent grassland (Regulation 316/1990Coll.). In 1994, the assessment of both cultures is merged by Regulation No. 178/94Coll. At this time there were not introduced any specific payments to any individual culture and current monitoring had not any essential reason.

Lack of the accuracy and reliability of the classification, especially concerning plots with a smaller acreage, when defining and mapping BPEJ during the time of the development of large scale agricultural production there were established and for this purpose used implementation methodology, outputs and purpose-build interpretation. For example areas smaller than three hectares were mapped in case of they had strongly contrasting character and their area was at least 0.5 ha. At the same time the contrasting character was considered the difference of five degrees of a slope difference in skeleton, texture and soil depth of at least two categories, waterlogging of land, etc. Flat projection of under limited shapes (smaller than 0.5 ha) were drawn into the maps by a mark.

BPEJ were maintained for evaluation of agricultural land even in the current system. BPEJ is still updated by the reclassification of “Soil-Ecological Bonity Units” (BPEJ) and for more accuracy which suits better to the new ownership relations and economic conditions of small farms. The original intention to establish a tax liability of the owner or a user failed to fulfil with regard to a need to simplify orientation in the system as well as some unresolved technical

problems at locating of BPEJ and thus started the calculation of the tax from the parcel according the average price BPEJ of land in the cadastral area. Use of BPEJ for economic purposes is reflected in the Act on prices and its implementing regulations. For the update of official prices of agricultural land, ÚZEI provides the documents and statements and are used in all cases where is impossible to use an individual (market) price of land, particularly for:

- Determining the real estate tax, (land tax),
- Calculation of the inheritance tax, gift tax and real estate transfer tax,
- Payment of income taxes for physical person, if the agreed price is lower than the price according the price regulation,
- The determining the price of a parcel during its appropriation for public purposes,
- Exchange of land plots during the comprehensive land consolidation,
- Determination of payments for withdrawal of agricultural land from agricultural production
- Determination of the estate in the application of the Act on Bankruptcy and Settlement,
- Design and budget activity,
- Regulating the use of agricultural land (putting land aside, conversion to other land types, etc.).

The actual official price is normatively fixed price based on the capitalization of rental effect (net income) determined for individual BPEJ according to 13 selected crops. Prices are for 2199 BPEJ in the CR updated by prising regulations to the Act No. 151/1997 Coll., about appreciation of the property and about the change of some laws (Act on Property Valuation). BPEJ are independently measured by rate CZK/1 m2. The price of land is formed in the part of achieved negative rental effects on the base of the assumption that the price of land must not fall below 5000 CZK/ha, the amount was later adjusted to 10 000 CZK/ha. Methodology for current pricing and value of agricultural land was described by Němec [8] and Štolbová [13]. Gross annual rental effect (HRRE) represents the difference between the normative values of production from 1 ha in CZK in the given structure of the crops and hectare yields, and the sum of inputs for their production. The current method of determining revenues and expenses is based on the factors given by configuration of plots, i.e. slope, exposure, depth of soil and skeleton. To indicate a production capacity of the soil are used in determining HRRE yields of main agricultural crops grown in the country. The crops grown on arable land are wheat, rye, barley, oats, grain maize, sugar beet, potatoes, oilseed rape, corn silage and perennial forage crops on arable land, that representing an area of more than 90% of the total arable land in the CR [18]. There is also evaluated permanent grassland on areas, which do not meet the requirements for environmental and economic management. Yields of main agricultural crops, including grassland are expressed for BPEJ suitable for their cultivation on the base of results of long-term monitoring of the impact of soil and climatic conditions on crop yields. At the same time are determined and applied coefficients for reducing the basic yields in the case of skeleton soils, slopes, and for their exposure to the south in the warm, dry regions and to the north in the cool, humid regions. Historically BPEJ were used in the sense economically necessary costs and revenues for the evaluation of companies in order to determine the support. These subsidies were not included in the measurement, otherwise it would not be possible the evaluation for the purpose of the support to be used. A similar importance is the assessment of land for the purposes of the LFA, which also includes the need for an objective assessment of economic conditions for business on agricultural land without any support. The problem with valuation of the current value of land is primarily in their use for tax and other purposes in case of application of the Act on prices, when prices are prices BPEJ used for property purposes. Market prices of agricultural land form an additional component of land evaluation, because, on contrary to the original pricing BPEJ now incorporate an influence of capitalization of subsidies and other effects of the investment behaviour of landowners. Gradually are formed four key levels for the assessment of land:

- **evaluation to determine the primary efficiency of agricultural production**, represented primarily by local needs of complex landscaping and objective values for evaluation of firms in relation to the possible need for the determination of the objective amount of a subsidy
- **evaluation for the need of soil conservation**, which is represented mainly by levies rates for agricultural land and for need of environmental payments
- **evaluation for the need of public goods, which to some extent penetrates environmental constraints and the LFA, but may have a relationship with the value of the landscape**
- **evaluation for property needs of landowners, fiscal and administrative value for the needs of the state, which is based on current market prices and yield prices**

From this list it is clear that a universal price list and the philosophy BPEJ is possible to realize in a very difficult way, it is necessary to set up a system that will be coherent and its target will meet the abovementioned needs.

The main research questions then are:

Can have a system of land assessment for the above mentioned purposes a common basis?

Is BPEJ and its economic evaluation an universal base suitable for the assessment of land?

Can be set an objective economic rate of return price BPEJ without influence of subsidies?

How to update the assessment?

1) Common approach

Basis for all purposes of land evaluation is possible on the basis of common features that can be expressed in the requirements for a stable system without major changes in the short term, the possibility of quantification of value relations, sufficient accuracy for the need of the abovementioned objectives. In consideration according FAO (2007) seem to be: evaluation of soil fertility in accordance with soil physical parameters (Fertility Capability Classification FCC, Sanchez [14]), evaluation of soil productivity in relation to yields of crops, evaluation of soil potential rating classes (depending on income, expenses on technology and the impact on social, economic and environmental values), subjective scoring of land with regard to individual land factors (Land evaluation and Site assessment LESA, presented by Wright, Young, Googins [19]), agro-ecological zoning (AEZ) described by Arshad and Martin [1] . These methods are further extended for the needs of farm systems (Land evaluation and farming system analysis - LEFSA etc.), Sustainable Land Management (SLM). Despite the relatively rich amount of methods for the land evaluation remains unresolved problem the own focus on the assessment according to economic output or by other indicators, and both systems have their positives and negatives. A fundamental attitude to this choice comes from the majority need on the proposed system if that should be used to evaluate production or in environmental context. Methodology for land evaluation is described in many other works, mainly by FAO, most methods to explain or predict the use potential of land describe Van Diepen et al., 1991 [15, 16]. The theoretical framework for land valuation, which is used also in the Czech Republic, analyse Rossiter [11,12]. Agro-environmental indicators are still more accepted in land valuation. The main challenger is given by Bruyas, Kayadjanian, M. & Vidal [2], and OECD [10]. Evaluation methods should take into account a range of objectives covering both local and global effects [20].

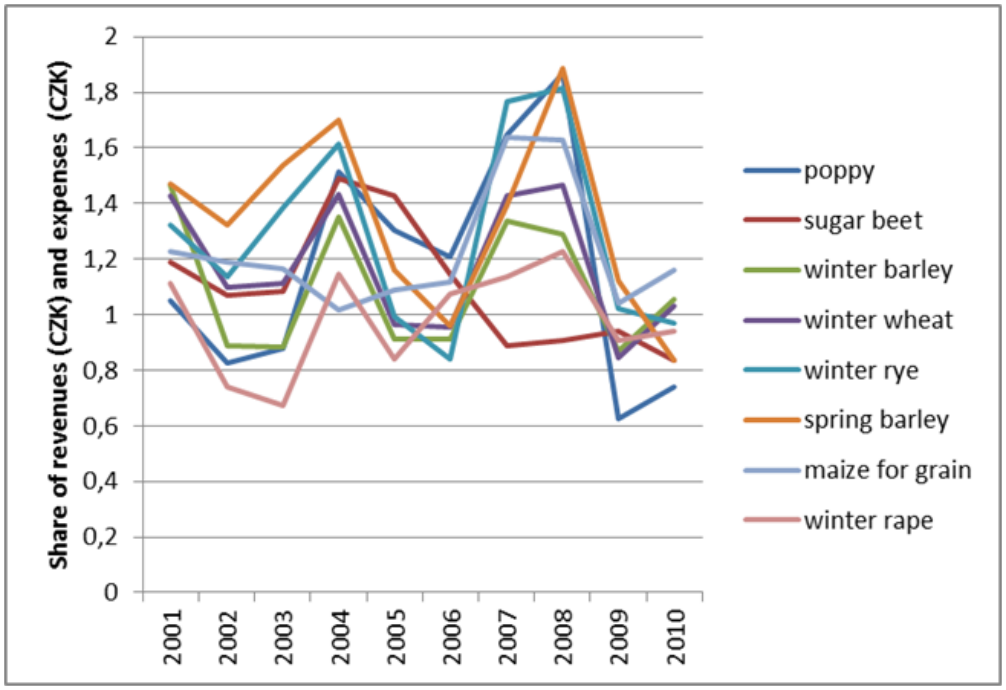
In the Czech Republic the evaluation was implemented in compliance with reached revenues and expenses (gross annual rental effect HRRE) and produced energy of the production process, which had been performed by VÚMOP in the early 80's (Novák [9]). The biggest advantage of the economic evaluation of land according to revenues and expenses is the possibility to set of value relationships based on objective economic calculation. In contrary there is instability of assessment based on current prices relations. Figure 1 shows the evolution of revenues and expenses of farms in the last ten years. From the course it is obvious a cyclical development of achieved prices.

Figure 1 follows that the heterogeneity of the results of each year in the absolute level of cyclic, but with the exception of maize grain the internal relations between crops remain essentially preserved. The comparison reveals even smaller differences between the profitability of the individual crop production in the last two years.

The absolute value of rental effects is influenced even the support of agricultural production, which forms an increasingly important item among individual years. Figure 2 is mentioned a comparison of the absolute size of the production subsidies by the each pillar of agricultural supports. By a comparison of both graphs follows that the absolute size of the supports has not a basic impact on the profitability of production, because it itself is adjusting market value of inputs and outputs. However the size of the aid is significantly reflected in the level of achieved rental effects without subsidies that reach mostly negative values.

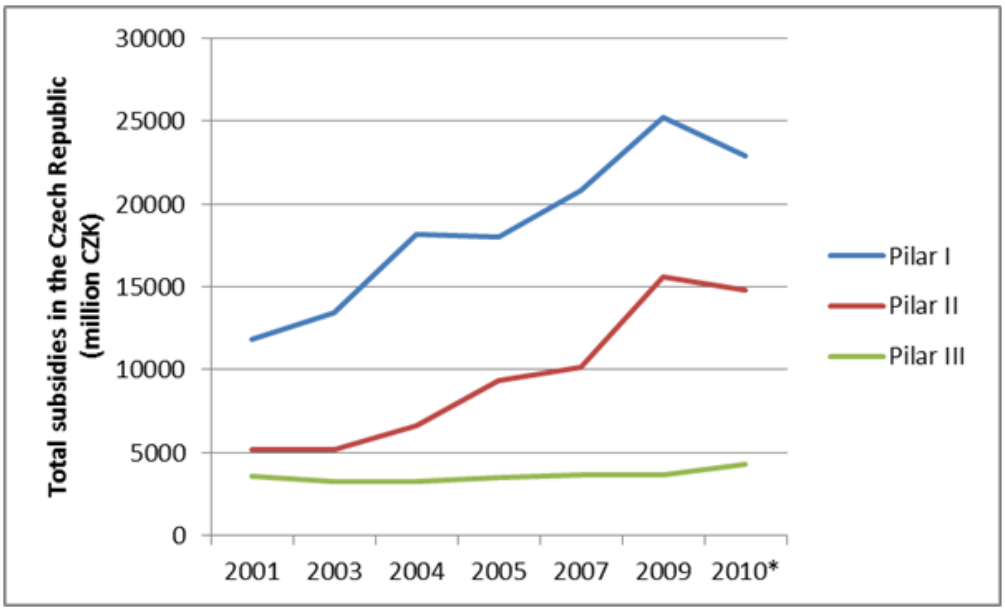
A distinctive significant impact on the development of internal relationships among BPEJ has however a relationship between the profitability of production on arable land and grassland, which is shown in Figure 3.

From the development are noticeable distinct trends of the growth of the price level of arable land compare to grassland. Market prices are derived from development in market prices of the Land Fund of the CR achieved sales of land under § 7 of Act No. 95/1999 Coll. as amended, by which was not put in the effect the thirty years instalment. At the beginning of the sales the prices reflected the price according to the calculated rental effects, but next further and quicker development of market prices of grassland was going on. In relation to agricultural policy a different development HRRE



Source: Expense survey ÚZEI.

Figure 1: Development of revenues and expenses of the main agricultural crops on one ton of a product.



*predicted
Source: ÚZEI.

Figure 2: of the total subsidies from 2001 to 2010.

has an impact on mutual equilibrium of arable land prices and prices of grassland, which are currently being evaluated in some cases, using the percentage of arable land, which represents the degree of extensification given by BPEJ. Percentage of arable land is given by the ratio of arable land to the sum of areas of arable land and grassland and is based primarily on research conducted at VÚMOP in 1990 (Kvítek [5]). The inclusion of this percentage of arable land in the determination of HRRE is potentially causing a different kind of dynamics concerning development of types of parcels directly in the base of evaluation affected by BPEJ. With regard to the current support of grassland, some fundamental changes are seen in the representation of grasslands, which are carrying out dynamically in recent years. Since 1996, grassland area of 81 000 ha has increased,

meanwhile the acreage of arable land decreased by 13 000 ha (source CUZK) . Grasslands are one of the main tools to contend with soil degradation and mainly against water erosion. Support of grassland is necessary for landscape maintenance, but the price of grassland is significantly less dependent on the production capacity of the soil than arable land and is more dependent on the current support. The basic question that should be answered to the above questions is whether the existing system BPEJ can be used both for the evaluation of the economic context as well as for environmental context given by the size of the corresponding restrictions on production. Another issue is to setting of the current assessment of land value.

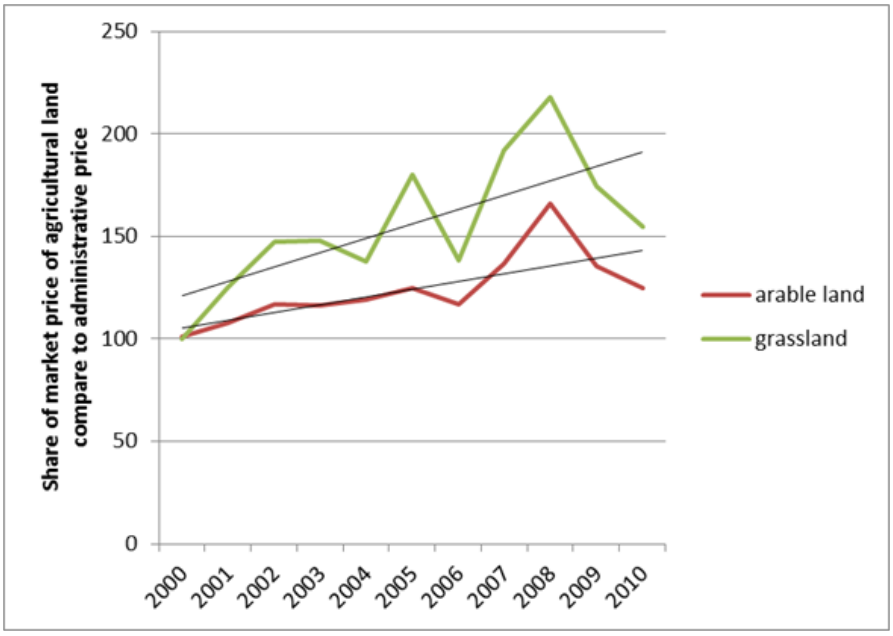
Methods of the proposal of BPEJ assessment

Relation between the agricultural production and the soil protection is the subject of the project NAZV QH72257 and methodology is given by Voltr [18]. Methodology is based on the model relations for expressing soil fertility through the production function according to Dabbert [3]. In addition to understanding the importance of each production factor on revenues and expenses is dealt also the impact of production even on soil compaction, relation to the use of nitrogen as the main component affecting soil productivity and at the same time the rate of the environmental damage and also biosphere levels in the soil given by humus content including biological activity of soil. The extent of erosion was not directly the content of this project, but the evaluation of technological operations for crops and by the inclusion of appropriate crops for the land assessment can be economically evaluated the impacts of measures against erosion on the costs and revenues on BPEJ. In relation to nitrogen as intensification factor can be expressed economic effects of restricting the level of inputs into the soil.

The overall approach to the evaluation of soil can be expressed by the diagram in Figure 4.

Indicators primarily affecting crop yields and costs

The main procedure for the determination of land value lies in the definition of key operating indicators in the production, based on crop production functions and evaluation of the economic impacts by standardized inputs in agricultural production. The proposed functions based on the operational monitoring of land can be extrapolated onto the other conditions of agricultural production, which were not the subject of monitoring. The base is the definition of **physical parameters of soil and properties HPJ, climatic indicators, indicators of crops nutrition, relation to technological processes and the relationship to the land configuration.**



Source: Land Fund of Czech Republic, own calculation.

Figure 2: Profitability of production on arable land compare to grassland.

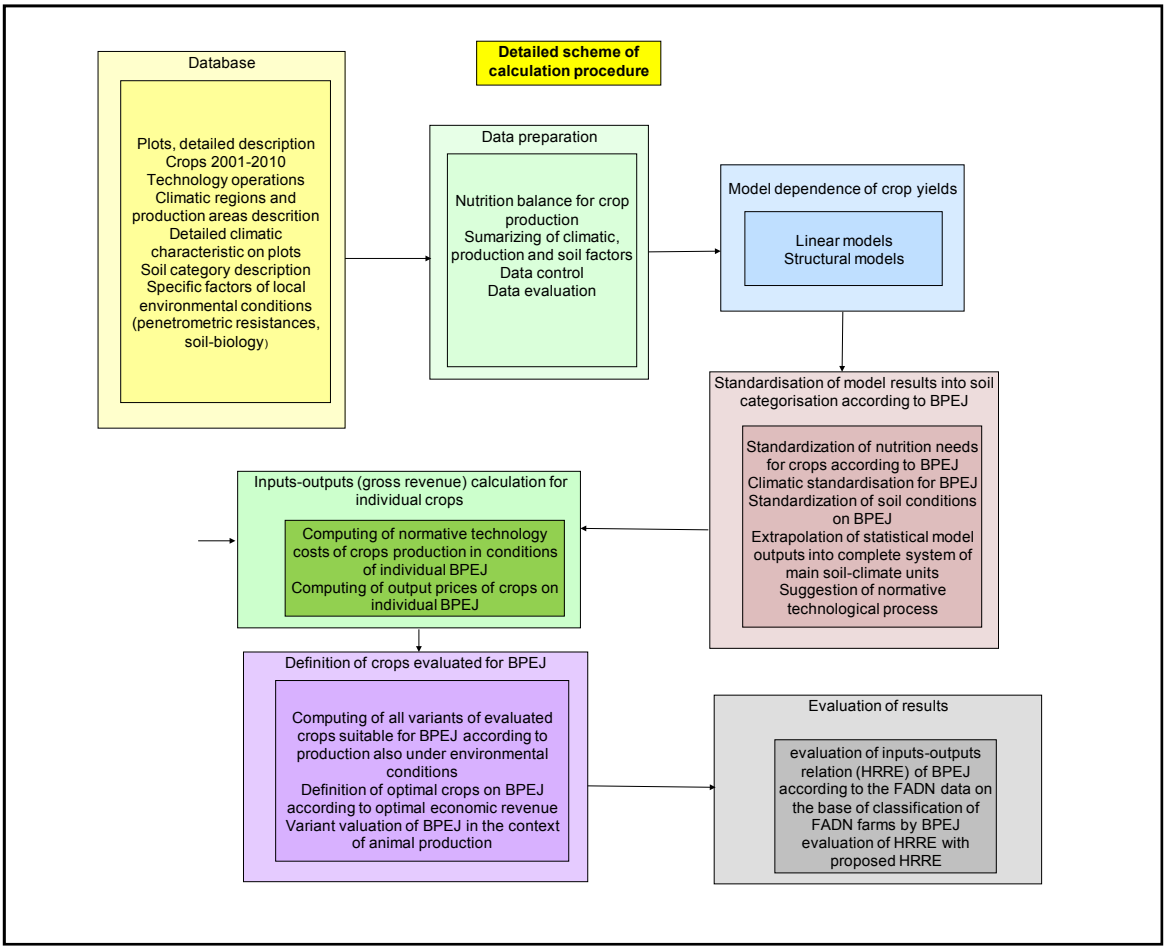


Figure 5: Scheme of the proposal solution of evaluation of BPEJ.

Results

Crop production functions consist of a set of basic models of mutual interaction among the basic variables used to predict crop yields, including the intensification factors, which are mainly a nitrogen dose and intensity of chemical protection. The results of the proposal are assigned to categorization of land according to BPEJ.

Production functions in the complex effect of these given factors including dependence on the dose of nitrogen explain revenues by the significant model, including the individual intensification elements. An example of prediction for winter wheat by climatic region is shown in Figure 5.

Crop yields were found out on the base of the production function coefficients for the standardized values of climatic factors. Due to the scattering of model values were yields adjusted by a maximum of 10% above or below the normative indexed yield on the current average of yields. Alternatively, the yields were estimated by VÚMOP points (Novák [5]). Based on the appraisal of groundwork about yields and assembled normative HRRE were calculated according to a new method of determination of revenues and expenses based in dependence on many items as follows:

a standardized dose of nitrogen fertilizer in the given conditions, and other elements in accordance with the consumption of nutrients by the crops, the number of chemical protection, the corresponding fuel consumption, live work and standardized technological procedures established for the given conditions. These costs reflect the objective conditions including the effect HPJ and soil texture.

Present results of the methodology proposal based on point values calculation HRRE on a point system (Voltr [17]) are shown in Figure 6 for arable land. The results are compared with the corresponding point value according to the data used from HRRE 2004 and with the original point value of VÚMOP. The results show on average a lower point value of arable land compared to the original point value proposal HRRE and VÚMOP. In the presented proposal of points is omitted the sugar beet in the rotation of crops, compared to previous crops the

selection became broader by triticale and poppy due to their area expansion of these crops. In this comparison supports are not considered. The selection of crops used in the proposal correspond to the long term yield and cost relationships in the period 2001-2010 based on the optimal HRRE for a variant proposal of crop representation on arable land (OTS). Different level of points between variants is given mostly by methodology for technology valuation (VÚMOP calculate only outputs) and by evaluation of grassland, because the present score is derived from both uses of land: arable land and grassland. Final relations of BPEJ is subject to final completion of project.

For the calibration of the proposal of evaluation is designed enterprise data analysis based on FADN data link according to the records of BPEJ. For the analysis method was chosen the method of the comparing proposals deviations from achieved reality by HRRE difference and the difference between revenues and expenditures of enterprises FADN. The present results show the legitimacy of the proposed approach, which exhibit the best agreement with the results of FADN network from all of existing valuation methods.

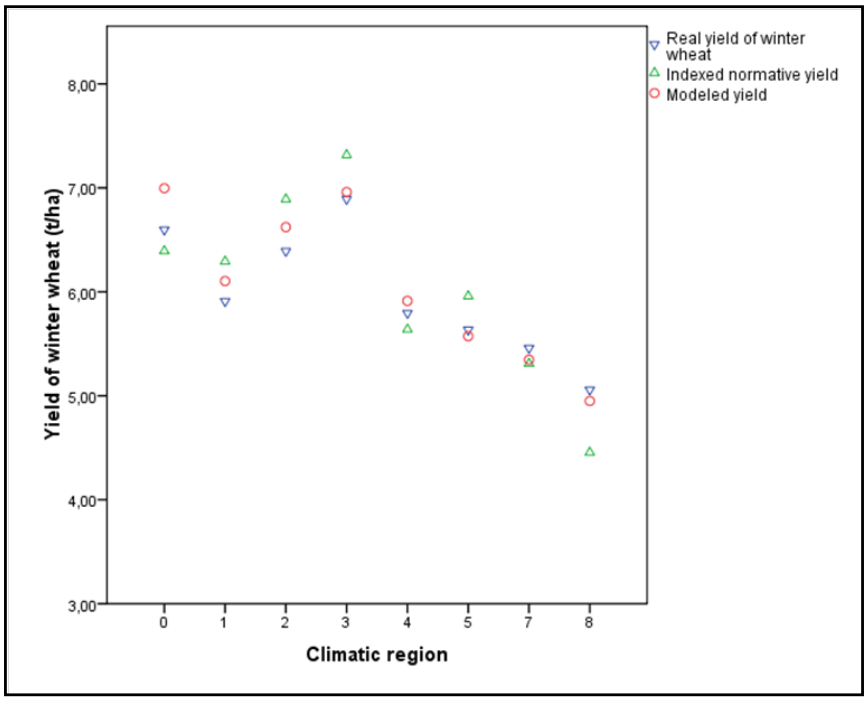


Figure 5: An example of prediction of yield of winter wheat according to climatic region.

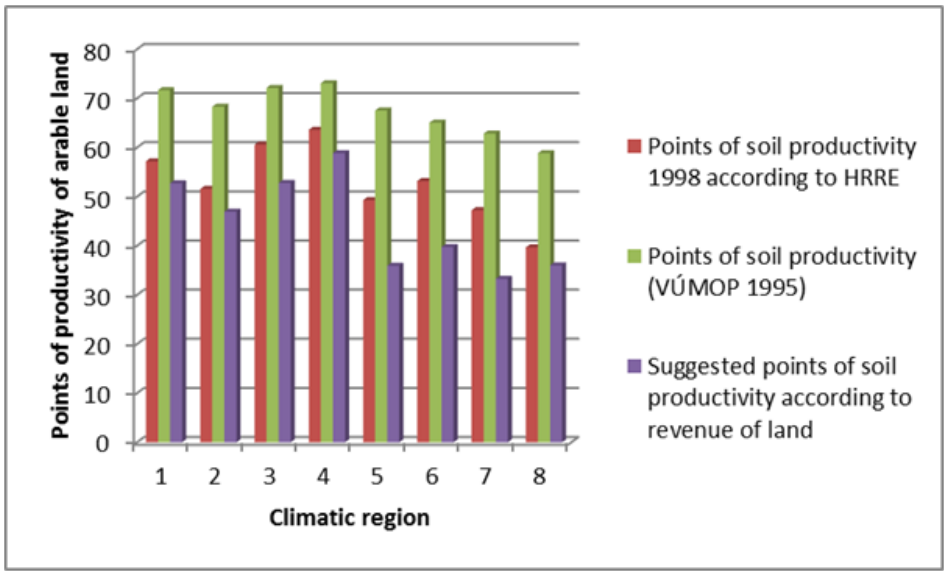


Figure 6: Comparison of point value course of arable land on the base of revenue calculation (HRRE).

Main conclusions for the evaluation of land in the future

Relations between revenues and material inputs to production are determined significantly by production functions that develop very slowly and can be seen in real time as constant. The slow development in time can be estimated on the basis of equivalent land evaluation results according to the VÚMOP method. What is important is the choice of valuated crops, which substantially affect the overall relations within BPEJ. The selection of crops used in the proposal correspond to the long term yield and cost relations in the period 2001-2010 based on the optimum HRRE for the variant proposal OTS.

For BPEJ indicators were found out significant links to the HPJ and the configuration of the terrain for most crops and thus remain an appropriate tool for assessing the relationship to the land. With the regard of demonstrated effect of soil texture on yields is appropriate to take into account possibilities for a better consideration of granularity in the classification of the soil.

Impact of subsidies is mainly seen in the difference in market land prices of grasslands resulting from a differing state subsidy policy in contrary to arable land. Due to potential and existing inequality in the development of prices of both cultures it can recommend their separate assessment.

Real gross annual rental effect from production fluctuates annually due to changes in input prices and output prices. If prices BPEJ should be kept up to date, then they could be proposed the following way:

A) The proposed fixed-point value under existing cost-yield relationship and optimization of representation valuated crops on the base of the stabilized proposed parcels of these crops. To accomplish appraisal of a one point according to the development of market land prices and the found average value of the market price in the current conditions at one point found from the set HRRE. To propose a point value alternatively for the environmental constraints on a parcel, in accordance with the inclusion of soil to the technological restrictions on the land including any possible individual appraisal.

B) Calculation of the corresponding official land prices in a given year, according to a cost-yield relationship under HRRE can be estimated on the basis of:

1. index development in prices of inputs and outputs of monitored crops in a given year with regard to the standardized long-term land price derived from long-term average yields and costs for already assembled crops on BPEJ
2. the annual update HRRE for individual BPEJ including the development of area of evaluated crops. This method of calculation is expected an annual change of terms BPEJ

With regard to the significant time demands and requirements for updating the source values can be recommended the option A. Using the price proposal according the original price calculation methodology in the area of negative rental effects also arises the problem of indexing the proposed prices, which is not possible to do by a linear method due to hyperbolic course of depending on land prices on HRRE in this area, under the previous methodology.

Separate part of the proposed update of BPEJ is also the possibility of using the observed data for modelling of production relations for the central purpose even of the frame business analysis in connection to the LPIS.

Crop production functions in BPEJ system may help by evaluating the impact of environmental constraints.

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Corresponding author:
Ing.Václav Voltr, CSc.
Ústav zemědělské ekonomiky a informací (Institute of agricultural economic and informations), Mánesova 75 , Praha 2, 120 56
Phone: +420 222 000 390
E-mail: voltr.vaclav@uzei.cz

References

[1] Arshad, M.A. Martin S.: Identifying critical limits for soil quality indicators in agro-ecosystems. Agriculture, Ecosystems and Environment 88, 2002, p. 153–160.

[2] Bruyas, P., Kayadjanian, M. & Vidal, C.2002. Results of the LUCAS survey 2001 on Land use. Building agri-environmental indicators. Report ot the European Commission.

[3] Dabbert, S.: Ekonomik der Fruchtbarkeit. Stuttgart, Ulmer 1994, 201 s. ISBN 3-8001-4092-6

[4] Klečka, M. et al.: Economic characteristic of soil-ecological bonity units in the Czech Republic. (Ekonomická charakteristika bonitovaných půdně-ekologických jednotek v ČSR). Final report VÚEZVž, 1980, Praha, 65 pp.

[5] Kvítek T. et al.: The principles of delimitation of cultures and use of grasslands in attenuation extensive conditions (Zásady delimitace kultur a využívání travních porostů v útlumových extenzivních podmínkách). VÚMOP, 1994, Praha, 60 pp.

[6] Land evaluation. Towards a revised Framework. FAO, 2007, 107 pp.

[7] Mašát K. et al.: Methodological principles of selection and evaluation of land for economic purposes. (Metodické zásady výběru a hodnocení vzorových pozemků pro ekonomické účely). Final report, 1973, ÚZPP, Praha, 58 pp.

[8] Němec J. (): Bonity and evaluation of agricultural land of the Czech Republic. (Bonitace a oceňování zemědělské půdy ČR), 2001, VÚZE, Praha, ISBN 80-85898-90-X, 257 pp.

[9] Novák P. et al.: Proposal of point valuation of soil. (Návrh stanovení bodové hodnoty půdy). Final report RE 093095002, VÚMOP, 1995, Praha, 13 str. 62 pp.

[10] OECD: Environmental indicators for agriculture. Organisation for Economic Cooperation and Development, Paris, 1999

[11] Rossiter, D.G.: Economic land evaluation: why and how. Soil Use and Management 11, 1995, p. 132-140.

[12] Rossiter D.G.: A theoretical framework for land evaluation. Geoderma, Volume 72, Issues 3-4, August 1996, Pages 165-190.

[13] Štolbová M. et al.: Proposal of innovated valuation profitability of the agricultural area. (Návrh inovovaného ocenění výnosnosti zemědělského území), second part, VÚZE. Annual report of the project No GF 3082, Updating LFA, 2005, Praha, 45 pp.

[14] Sanchez, P.A., Coutol, W., Buoll, S.W.: The fertility capability soil classification system: Interpretation, applicability and modification Geoderma, Volume 27, Issue 4, June 1982, pp 283-309.

[15] Van Diepen, C.A., Van Keulen, H.. WolL J. and Berkhout, J.A.A., Land evaluation: from intuition to quantification. In: B.A. Stewart (Editor), Advances In Soil Science. Springer, New York, 1991, pp. 139-204.

[16] Van Diepen, C.A., Wolf, J., Van Keulen, H. and Rappoldt, C. WOFOST: a simulation model of crop production. Soil Use Manage., 1989, 5: p. 16-24.

[17] Voltr V.: Evaluation of agricultural land fund by point method (Hodnocení zemědělského půdního fondu bodovou metodou). VÚZE, 1998, Prague, 40 pp.

[18] Voltr, V.: Methodology of agricultural land resources valuation with respect to environment conservation. (Metodika hodnocení zemědělského půdního fondu se zohledněním ochrany životního prostředí). Economics of Agriculture, VIII, 2008, No 4., p. 82-89, ISSN 1335-6186.

[19] Wright L. E., Zitzmann, W., Young, K. Googins R.: LESA—agricultural land evaluation and site assessment. Journal of Soil and Water Conservation March/April 1983 vol. 38 no. 2, p. 82-86

[20] Werf, H.V.D., Petit, J.: Evaluation of the environmental impact of agriculture. Agriculture, Ecosystems and Environment 93,2002, p. 131–145.